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CSTD Panel Meeting on

Biotechnology for Food Production and Its Impact on Development

Report by the secretariat

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EXECUTIVE SUMMARY

1. With its wide array of techniques and applications, agricultural biotechnology offers the potential for increasing and improving food production capacity and promoting sustainability. However, developing countries are deriving only limited benefits from it owing to declining public sector investments in agricultural research and development and to the dominant role that multinationals and the private sector currently play in biotechnology. The global seed trade is dominated by large private industry giants whose vast economic power and commercial control over plant germplasm is beginning to overshadow the role of the public sector in plant breeding and other agricultural research in many countries. Strong and restricted protection mechanisms of biological resources have made biotechnology less accessible, and this has led to serious inequities between developed and developing countries. In an attempt to shed more light on this and other issues, the Commission on Science and Technology for Development (CSTD) decided to identify areas where further work needs to be done in biotechnology acquisition, adaptation and diffusion. In response to this request, a Panel meeting on biotechnology was convened by UNCTAD from 21-22 January 1999.

2. The discussion was organized around three thematic areas: (i) issues related to plant and animal species and their traits, as well as to some biotechnology techniques and their applications at the local level; (ii) endogenous capacity-building for the development and transfer of biotechnology, including mechanisms for integrating biotechnology into the mainstream of agricultural research; and (iii) other critical issues related to biotechnology which may have an impact on food production, particularly those that need to be addressed at the international level.

3. Although modern agricultural biotechnology is often associated with the large-scale crop production in industrialized countries, its techniques could in fact be used to enhance the traditional small-scale mixed-crop farm setting as well. The Panel discussed the potential role of genomics in crop improvement and emphasized the need to improve food crops for domestic consumption and for exports in anticipation of global population increase in the next millennium. The experts noted that biotechnology could potentially be a means of "wealth creation" and a basis for international commercial competitiveness. They also highlighted the role of biotechnology in extending post-harvest life and in improving nutritional contents as traits which could be an immediate boon to developing countries' food sufficiency programmes. The Panel cautioned that the introduction of biotechnology into the agricultural sector should be monitored closely in order to prevent adverse effects on biodiversity. It also pointed out that each country needs to pursue its own development priorities in biotechnology, including genotyping and preserving the country's biodiversity. In this context, the Panel expressed the need for global networking in biotechnology, involving both private and public sectors, as a means for sharing and disseminating information, knowledge and experience, as well as for identifying potential sources of financial support and training opportunities. Global networking should be catalysed and supported by the international community, including multilateral and bilateral donor agencies and technical assistance institutions. The Panel called on CSTD to initiate, in coordination with the Consultative Group on International Agricultural Research (CGIAR), the World Bank/Food and Agriculture Organization (FAO)-based Global Forum on Agricultural Research, and other partnership-promoting organizations, a dialogue between all stakeholders involved in biotechnology, including international organizations, NGOs and the private sector. It also discussed other issues of global concern, such as the possibilities for benefiting from biodiversity and preserving it and the impact of an introduction of "terminator gene" technologies into agricultural seeds.

4. In discussing constraints in advancing biotechnology in many developing countries, experts pointed to the following impediments:

i. lack of, or vague, policies in science and technology (S&T), particularly in biotechnology;
ii. lack of adequately trained manpower in biotechnology;
iii. poor access to up-to-date information on new concepts and techniques;
iv. inadequate funding for research and development(R&D);
v. strong and restricted protection mechanisms of biological resources.

5. In many developing countries, interest in biotechnology is still largely confined to the public sector, mainly in universities and government research institutions. Participants stressed the need to involve and engage the private sector. There was agreement that if commercialization were to be an imperative in the development of biotechnology in developing countries, a number of approaches to commercialization would have to be considered. These include educating the industry and investors on the potential benefits of biotechnology; encouraging industry and private sector participation; developing linkages between industry, investors and the scientific community; and providing incentives to R&D personnel in commercialization ventures.

6. In discussing the policies that need to be developed to advance biotechnology in developing countries, the Panel recommended that Governments in those countries should undertake the following strategies:

i. strengthen research capability and build endogenous capacity in biotechnology;
ii. embark on programmes to train skilled manpower at the tertiary as well as at the technical support levels;
iii. identify and encourage the development of "centres of competence" in biotechnology in each country;
iv. develop and maintain strategic alliances and networking with "centres of excellence" in developed countries;
v. encourage linkage and interaction between the public and the private sectors;
vi. identify, develop, and disseminate balanced information on biotechnology, intellectual property rights (IPR) and biosafety;
vii. develop case study approaches to address technology/IPR/biosafety issues in a practical, understandable and concrete way.

7. In support of national and regional initiatives to promote appropriate use of biotechnology in developing countries, the Panel re-emphasized the need for cooperation between UNCTAD, FAO, the United Nations regional economic and social commissions, the World Bank, non-governmental organizations (NGOs), and other international institutions such as the CGIAR and the Global Forum on Agricultural Research.

1. Introduction

8. Pursuant to Economic and Social Council resolution 1997/62, the CSTD was requested to convene a panel meeting on biotechnology and its impact on development, with particular attention to food production, for the purpose of identifying critical issues relevant to development that are not sufficiently covered by existing forums and recommending how further work on those issues might be undertaken. The Panel Meeting was held on 21-22 January 1999, in Geneva. It comprised Commission members, other biotechnology experts and members of United Nations agencies. The UNCTAD secretariat prepared an issues note entitled "Biotechnology for food production: issues for consideration"(E/CN.16/1999/Misc.2), which provided background information and identified critical issues relevant to development.

9. The issues paper recalls that global food demand is expected to double over the next 50 years and argues that conventional food production technology alone will not be able to meet this demand and that biotechnology could be an important vehicle for developing countries to meet the objectives of food sufficiency while at the same time safeguarding the environment. Modern biotechnology -- ranging from plant tissue and cell cultures to the transfer of genetic material between plant or animals -- has expanded the tools available for crop and animal improvement. It offers possibilities for short-circuiting traditional trait selection processes and overcoming conventional barriers of genetic incompatibility. It can also contribute to increasing food sufficiency through improving the genetic potential of varieties and animal species, by minimizing cultivation stresses and enhancing certain characteristics such as nutritional content and post-harvest shelf-life. Moreover, since it is scale-neutral, it could be used in small-scale farming, which constitutes the backbone of most developing countries' agriculture industry. However, the experts warned that biotechnology cannot be expected to be a panacea for all problems related to food production.

2. Species and traits: techniques and applications relevant to developing countries

10. The Panel noted that research to date has focused predominantly on temperate zone crops and on farming conditions prevailing in industrial countries. Biotechnology-related knowledge regarding certain crops, which are staples in the traditional diet of most people in developing countries, is still limited. In view of the prevalence of small-scale farming in most developing countries' agricultural sector, biotechnology could be used to improve mixed-farming and to best preserve the natural ecosystems. Special consideration should be given to "orphan" crops and to underutilized species, since a broad-based botanical resource could provide more possibilities for creating new improved strains and novel food sources.

11. Some experts noted that the "first generation" of genetic engineering applications in agriculture was aimed at improving traits involving single genes. To a large extent, this process has been driven by the commercial interests of firms. It has resulted in the development of pesticide or herbicide varieties that did not necessarily fit the needs of developing countries. Some of the traits that could make a difference in developing countries' agriculture, such as protection against certain pests and increasing stress-tolerance, often involve more complex gene transfers. The development of these technologies were within reach of some developing countries. The more technologically advanced developing countries could serve as regional centres of excellence for the development and use of biotechnology that meet the needs of developing countries.

12. It was also pointed out that there were biotechnology research laboratories in Europe working on tropical crops. The experts emphasized the

need, frequently expressed by others, for networking with such biotechnology initiatives. To illustrate the merits of link-ups with more advanced scientific centres, the case of the successful biotechnology production of interferon, which resulted from linkage between laboratories in Cuba and Finland, was given. Another example cited was the Institute for Genomic Diversity at Cornell University, United States, which has been established to develop and apply genomic technologies and computational tools for the conservation, evaluation and utilization of plant genetic resources worldwide. It will provide a site where scientists from both public and private sectors can meet to address germplasm issues and related policies, as well as to receive exchange experiences. Its membership currently includes several CGIAR centres, the national research institutes of Brazil, China and India and the United States Department of Agriculture/Agricultural Research Service (USDA/ARS).

13. The "Green Revolution", it was recalled, had caused the disappearance of original parent crop strains. It is thus important to preserve native species in tandem with the development of a biotechnology programme. An inventory of genetic resources might be undertaken as a first step, followed by a carefully planned and thoroughly executed strategy on the optimum exploitation and use of local genetic resources. In the discussion an expert noted that tropical and subtropical biodiversity and ecosystems remained largely understudied and unmapped. Therefore, the introduction of genetically modified organisms might have consequences different from those observed under laboratory conditions or field-tested in temperate regions. Cases of clandestine testing were cited, and the Panel urged that developing countries be advised to take precautionary measures, including the use of legal instruments, to discourage such an eventuality. Where testing is called for in national biotechnology programmes, security measures should be taken and developments monitored closely.

14. A number of areas where biotechnology could make a contribution were discussed. It could be used to improve tree varieties in order to strengthen their roles as sources of food, lumber and other raw materials. It could also be modified to facilitate and accelerate reforestation, which among other things would result in improved climate conditions favourable to farming. Livestock and dairy products are important food sources, but animal husbandry in developing countries has been rather limited. Biotechnology techniques have been used in industrialized countries to shorten the period of maturity, optimize milk yield and immunize animals against common diseases, as well as to expand and improve the materials used in the industrial processing of animal feed. The Panel pointed out the untapped potential of micronutrients for resolving food shortage and malnutrition.

15. Another area of importance is the change towards agricultural practices that do not damage the environment. For example, tropical soils are extremely susceptible to erosion. Over the past 50 years, some 25 per cent of the topsoil on earth has been lost around the world, mainly in tropical areas. However, since tropical countries may face a food shortfall, efforts should be made to improve agriculture productivity, and this will best proceed through a better understanding of the ecology of tropical soils. This is especially true for mixed cropping on small farms. The Panel saw a need for a new strategy involving the development of biotechnology alternatives that help to minimize or even eliminate many of the environmental problems caused by current agriculture practices, with a view to identifying them at both the regional and country levels.

16. The Panel emphasized the need to find solutions to the negative environmental impacts of traditional forms of agriculture, such as monoculture, soil tillage and irrigation on a country-by-country basis. Such programmes should stress the need for technologies focusing on improving the quality of life of small farmers and marginal communities and on regional

agriculture.

17. Progress also needs to be made to better understand the traits that would best address the farming needs and geo-topographical conditions prevalent in developing countries' agriculture. Of primary importance to many developing countries, for instance, would be the reclamation and cultivation of areas considered non-arable under conventional agricultural methods. The carrying capacity of productive farmlands would not be jeopardized through overuse if new territories were brought into cultivation through the use of new plant varieties with enhanced traits. Such traits could include salinity and alkalinity tolerance for island and coastal countries; adaptability to conditions in drought-prone areas, such as sub-Saharan Africa and areas ruined by overgrazing; and enhanced biological nitrogen-fixing capacity of bacteria. Developing countries beset by similar geo-agronomic problems might pool their capacities and resources together to resolve these specific problems.

18. In discussing traits and techniques, one expert pointed out that traditionally many agro-businesses have been choosing "cash crops" and "cash genes" for commercial applications. As a result, crops that have received more attention for commercial reasons have not necessarily been those of importance to developing countries' farmers. Another expert noted that the lack of incorporation of wild and primitive crop relatives has already caused a lag in increasing productivity and a narrowing of the germplasm base. A change in crop breeding is needed in which direct evaluation of useful genes replaces an inefficient and sometimes even misleading search for useful phenotypes. Direct evaluation of useful genes is possible using the tools of modern biotechnology.

3. Policies and institutional capacity-building

19. At the outset of the discussion, it was pointed out that the traditional channels for agricultural research and applications for many developing countries have been eroded by diminished development assistance funding and curtailed domestic public spending and that the private sector has taken on a more active and dominant position in this area. Biotechnology acquisition of most developing countries has often come from a local subsidiary's import from its parent company in industrialized countries. As a consequence, the type of techniques imported and their applications are often based on commercial considerations and may not always be in line with the national priorities or local needs of developing countries. Furthermore, due to media attention to novel biotechnology developments (for example, in genetic engineering), some policymakers have adopted the notion that biotechnology *per se* is a high-technology tool, exclusively in the hands of the private sector and not able to be mastered by developing countries. Many Governments have consequently adopted a resigned "hands-off" approach in this matter. It was stressed, however, that biotechnology need not be "high-tech" to be useful to poor countries. A biotechnology effort focused on the agriculture of the poor could do wonders to eradicate poverty. Similarly, food processing and preservation technologies can be quite constructive. The Panel advised Governments to determine and influence the pace and type of biotechnology used within their borders and stressed that public support in the form of clearcut policies and incentives, or in the form of financial and infrastructural assistance, could serve as a catalyst in the acquisition and adaptation of biotechnology. Policies and institutional support and linkages related to biotechnology also need to be complementary to, and part of, the overall national agricultural strategy.

20. Building a national capacity for biotechnology research and application requires policies that stimulate investment in biotechnology research and its application, institutional support structures, and the development of local research capacity in biotechnology as well as its integration into the

entrepreneurship and competition. However well defined they may be, policies are ineffective if they are not coupled with action-oriented strategies focused on specific areas such as acquisition, adaptation, monitoring and risk assessment.

21. In this connection, the roles of the different economic agents could be assessed and monitored to develop a coherent and appropriate biotechnology programme in line with the national development agenda. These economic agents could include not only commercial entities, such as seed factories and outlets, but also farmers as purchasers and consumers. Knowledge of the agricultural, industrial and commercial structures could be used in policy formulation, not excluding the possibility of interchanges in functions. Traditional academic and research institutions, for instance, could take on the role of commercial outlets for biotechnology products and techniques, and vice versa. Furthermore, the private sector could assist traditional funding sources in bridging the gap in R&D. To optimize use of resources and ensure effective participation of all stakeholders, cross-sectoral approaches in policy formulation and strategic planning should be taken.

22. The Panel highlighted the importance of traditional crops, which the livelihood of many small-scale farmers depends on and which are a source of foreign exchange earnings (e.g., coconut, palm oil) in many developing countries. If measures are not taken to improve competitiveness to achieve higher yields and lower production costs, these products can eventually be replaced by substitutes. Thus, in addition to the economic consequences, a people's alimentary tradition and culture could be threatened.

23. It is therefore important to integrate biotechnology research into national agricultural research activities. It is also important to consider the successful transition from research to commercialization is assured and the demand structure of users. Planning can include marketing prospects at home and abroad, as well as potentials for expanded use of agricultural produce in food processing and other industries.

24. Given the strong likelihood that biotechnology will become an increasingly important force in food and pharmaceutical production in the future, the Panel re-emphasized the importance of its integration into the national development programme. Central to this is the development of national R&D and risk assessment capacities which allow each country not only to pursue its own development path but also to protect its own genetic resources and food production sector. The transfer of biotechnology specimens, even between seemingly similar agronomic conditions, may still require adaptation. Such is the case of a high-performance nitrogen-fixing bacteria developed and used in Brazil. When transplanted to Cuba, the bacteria did not show its nitrogen-fixing properties.

25. In concluding the discussion on this theme, the Panel urged that in-depth studies on the socio-economic impacts of biotechnology be undertaken. Ecological studies are also needed to better understand the impact of biotechnology on biodiversity. These are important subjects that have not been studied thoroughly. The CSTD, through UNCTAD, can play a major role in monitoring product displacements or variety disappearance due to the use of biotechnology, as well as its effect on employment, rural development and food sufficiency.

4. Information, cooperation and networking

26. There was a strong agreement that ready access to information and networking for the acquisition and diffusion of biotechnology as well as public awareness of its potential benefits are vital requirements for the advancement and commercialization of biotechnology. The Panel was of the view that both horizontal and vertical networking are essential; horizontal

networking among countries of similar topographical characteristics will eliminate duplication and stimulate research, whereas vertical networking with more advanced countries can lead to access to newer and more up-to-date technologies and training opportunities. To date, there has been no adequate assessment of the policies, networks, institutions and other supporting infrastructures required to promote the development, diffusion and assimilation of new techniques in biotechnology.

27. While a vast array of biotechnology knowledge has been acquired over the years, little information has been transmitted to the public. Some experts noted the slow transfer of technology and knowledge to developing countries. Others attributed the gap between the pool of available and accessible biotechnology and its low rate of diffusion to developing countries to the fact that such technologies are protected by IPRs. Over the years science has flourished because of the free flow of information around the world. Now, however, because of the strengthening of IPR rules and the growing importance of commercial deals between the major players in biodiversity, there is a risk that IPRs are restricting the free flow of information and limiting the ability of countries to participate fully in the exchange of knowledge and information. Thus, more information on the impact of IPRs on the transfer of technology is needed, as there is very little empirical evidence to support the view that strong IPRs are required to facilitate the transfer of technology, as is frequently claimed. It was further stated that, while weak IPRs may hinder technology transfer and investment, strong IPRs may not help promote them either.

28. The Panel said that international organizations and institutions as well as intergovernmental bodies such as the CSTD and UNCTAD could be instrumental in making biotechnology information available to countries concerned and in facilitating the transfer of technology. The large transnational biotechnology companies should also be encouraged to provide factual and balanced information on biotechnology. There is a need for the compilation of a roster of biotechnologies which are already in the public domain and do not require licensing. In this connection, it was recommended to use the World Bank/FAO-based Global Forum on Agricultural Research and its Internet-based information/communications tool, the Electronic Global Forum on Agricultural Research (EGFAR), as vehicles to foster networking and information flow/communication between all stakeholders. The Global Forum was recently created as an organizational framework to stimulate improved information flow, communications, and partnership-building among all stakeholders in agricultural research and development worldwide. Other international development bodies could also actively promote the transfer, adaptation and diffusion of biotechnology.

29. More efficient networking and the building of linkages between the private and the public sectors are needed in the area of crop improvement. For example, more efficient breeding programmes are needed. The Panel expressed the view that biotechnology initiatives and programmes in developing countries, particularly those supported by developed countries, should take into account these needs and priorities at both the grass-roots and R&D levels.

30. The Panel stressed the importance of South-South cooperation and networking and cited Brazil, China, India, and the Republic of Korea as examples of developing countries that have achieved high levels of R&D capabilities and acquired long experience in biotechnology applications. Biotechnology laboratories can be expensive to set up in all countries, and it was recommended that regional centres be established to facilitate biotechnological testing, identification and experimentation. Besides linkages among stakeholders at the country level and with agricultural institutions in other developing countries, efforts should be made to link up with and become counterparts to agricultural research institutes in

industrialized countries in order to access more advanced technologies. These arrangements can lead to a more informed and coherent selection of techniques to be acquired at favourable prices within a shorter time-frame.

5. Critical areas for further work

31. Advances in biotechnology have opened a new era for food production, and the evolution of science and technology has outpaced the development of laws and policies. However, the implications of advancement in this new technology, especially in the area of biodiversity, biosafety, IPRs, production patterns and other critical factors are not yet sufficiently understood. The Panel discussion attempted to shed more light on some of the areas which have generated much of the controversy and debate surrounding modern biotechnology:

(i) *Biosafety*: Some experts pointed out that negotiations among the member countries of the Organisation for Economic Co-operation and Development (OECD) have led to the formulation of safety guidelines intended primarily to prevent the spread of harmful laboratory-created micro-organisms into the environment. A global code of conduct for the release of organisms into the environment has been developed within the framework of the United Nations Industrial Development Organization (UNIDO). Nevertheless, there has been continued concern over reported violations of the safety measures. It was noted that countries are sometimes uninformed of the potential benefits and risks of this new technology and often do not have sufficient capacity to enforce existing policies, regulations or guidelines governing its use. In discussing the options available to developing countries to ensure biosafety, the Panel suggested that biotechnology innovations be made in tandem with research work on their impact on ecosystems, particularly tropical ecosystems which prevail in developing countries. Another facet should be consumer health and safety, which could include labelling of foods containing genetically modified organisms. It was also suggested that experiences with regard to breaches of biosafety and work on biodiversity be more assertively shared between regions, centres and countries.

32. One expert also pointed out that amidst announcements of controversial biotechnology experimentations and reports of illegal field-testing of artificially created plant specimens, the potential benefits of biotechnology in general and the safety in the use of more mature biotechnology in particular are often overlooked. Fear and controversy arise from lack of information, often fuelled by sensationalism. Like other scientific knowledge, biotechnology is an evolving process that is still fraught with unknowns. However, there should be a concerted effort to provide frank, honest and balanced information on the state of biotechnology, its uses and benefits as well as its shortcomings and risks. The Panel invited countries to weigh their own food sufficiency problems against potential risks of biotechnology and against potential consequences of non-use.

(ii) *Biodiversity*: Like preceding technologies in the biosciences, biotechnology has influenced and will further influence agro-biodiversity. In the past, higher food production based on high-external-input varieties caused the loss of traditional varieties and their genetic diversity. Given certain conditions, modern biotechnology could strengthen this effect. In some developing countries, a combination of weak or nonexistent policies on the one hand and the efforts of private firms on the other has already stimulated a shift from food production for subsistence for local communities to large-scale production of few crops and varieties for national and international markets, resulting in a loss of diversity.

33. Modern biotechnology can preserve biodiversity. With minimal agro-chemical input and water intake requirements, biotechnology has more potential than conventional agricultural practices for safeguarding and in certain cases rehabilitating the natural habitat needed for ecosystems to exist. The Panel

stressed the need for safety testing of newly introduced biotechnologically designed crop varieties.

34. The Panel agreed that biodiversity was a resource which had hitherto been unprotected and taken for granted in many developing countries, and urged that gene banks be established to protect and preserve them. Furthermore, while most developing countries have natural resources, they often do not have the techniques to exploit them on their own. Carefully negotiated bio-prospecting arrangements could be one way to access techniques and know-how for cataloguing gene specimens and exploiting botanical resources within a national biotechnology programme.

35. With the Convention on Biological Diversity (CBD) Protocol being further negotiated, the Panel urged that developing countries' concerns be more effectively and strongly represented. The CSTD could facilitate this by establishing a working contact with the CBD secretariat and taking note of ongoing negotiations. Additionally, it could undertake and publish case studies with a view to promoting understanding of the Convention. In concluding the discussion on issues related to biodiversity, the Panel reiterated that, depending on their technological capacity in key areas such as risk assessment, developing countries need to develop their own basic regulations and to carry out risk assessment.

(iii) *The patenting of life forms*: Most new biotechnologies are proprietary and are therefore less accessible, in particular to researchers and users from developing countries. Patenting in itself is a complicated and expensive process. One expert noted that developing countries are often "patented out" of the whole IPR system. This has raised concerns among developing countries, especially since biodiversity in many such countries often provides large stocks of untapped genetic resources to be utilized in areas such as agricultural and pharmaceutical development.

36. It was pointed out that at present, the agreement on Trade-related Aspects of Intellectual Property Rights (TRIPS) and the CBD sometimes seem contradictory in their objectives and practices with regard to access to and remuneration for plant genetic resources. It was important to understand clearly how these different agreements could be made compatible by linking IPR laws with non-IPR access and enumeration systems for plant genetic resources and how farmers' rights could be strengthened in this context.

37. The Panel expressed the view that this matter is very complex. Because IPR is a highly specialized area requiring legal expertise and consummate negotiating skills, it was suggested that an interface facility might be set up to patent, license and commercialize biotechnology techniques and ensuing products. This facility could also screen incoming products and techniques to ensure they are in line with national needs and conditions. In countries where they already exist, technology transfer centres could undertake these functions.

(iv) *Seed sterility variants, or "terminator gene"*: This technology's built-in gene sequencing renders seeds sterile and good for one-time use only. Patent holders have hailed it as a "technology protection system", which would ensure the continued development of new traits and technologies for commercial varieties by providing individuals and companies with a fair return on their investment. Certain NGOs, however, have dubbed it "terminator" or "traitor" technology in that it would terminate farmers' independence and threaten the food security of resource-poor farmers in developing countries where farm-saved seed accounts for an estimated 80 per cent of total seed requirement. On the one hand, by forcing farmers to use new seeds for each planting, this technology could facilitate the transfer and use of improved and better-adapted strains and varieties. On the other hand, seed-saving is considered necessary for farmers to adapt the seeds to their own needs and to local

conditions, thereby generating and nurturing biodiversity. It also ensures that fragile distribution and financing systems common in the developing world do not lead to a crisis in food production if seeds cannot be obtained in time for planting. Other uncertainties related to the use of this technology are potential gene-jumping to wild species and unintended transborder transfer to adjacent countries. The Panel stressed the need for more research and studies in order to better understand the benefits and drawbacks of the technology and its socio-economic impact in developing countries.

6. Recommendations

38. The Panel raised a number of issues that resulted in specific recommendations to both Governments and the international development community in terms of policy options and guidelines for different stakeholders involved in advancing the proper use of biotechnology for food production. The Panel recommended the following strategies:

- Identify, develop and disseminate balanced information on biotechnology, IPRs and biosafety. This could be done through the distribution of a series of concise leaflets on biotechnology providing a balanced view of the issues in easily understood language, to be disseminated to stakeholders in biotechnology development, including acquisition, deployment and improvement in developing countries;

- Undertake studies on the relationships between IPRs and technology transfer and develop a case study approach to address technology/IPR/biosafety issues in a more practical, understandable and concrete approach;

- Encourage networking and linkages between the public and private sectors and encourage interaction between industry, investors and the scientific community; this could be organized jointly with the Global Forum on Agricultural Research and the CGIAR;

- Build endogenous capacity and strengthen research capability in biotechnology through training skilled manpower and providing incentives for R&D personnel; this should be coordinated with the World Bank, which is developing a new strategy to build national capacities in biotechnology throughout the developing world;

- The international community should support developing countries in their efforts to develop and diffuse biotechnology to provide food for their population;

- Encourage private-sector participation by educating the industry and investors on the potential benefits of biotechnology;

- Provide support for mechanisms encouraging private firms to adapt and apply new technologies, and find new ways of financing firm development, such as building venture capital industry in developing countries;

- Establish strategic alliances and networking with "centres of excellence" in developed countries and encourage interaction with pioneering initiatives, such as the Institute for Genomic Diversity, which was recently established at Cornell University, United States, to develop and apply genomic technologies and computational tools to the conservation, evaluation and utilization of plant genetic resources worldwide;

- The CSTD, through UNCTAD, should identify and initiate dialogues that involve the private and the public sectors, and NGOs, with a view to

fostering the exchange of information and ideas among scientists, policy makers, industry, and end-users. Such dialogues could also provide a forum to raise issues concerning global developments in biotechnology (e.g., IPRs, biosafety) and to stimulate frank discussions and raise public awareness of the potential benefits of biotechnology and other critical issues. This work could be done in cooperation with the EGFAR;

- The CSTD should also address the need for regulatory capacity-building in biosafety for all countries. International organizations such as the United Nations Environment Programme, UNIDO, FAO and the World Health Organization, as well as individual countries such as Australia, Canada, France and the United States, have been involved in major biosafety projects. The CSTD should disseminate the results of other efforts already under way and support those initiatives which have proved useful and helpful in designing national biosafety programmes suitable to local needs and priorities.